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Long-acting wide-spectrum antiseptic nanometer silver fabric has superfine silver grains adhered between or on fabric fibers, with silver having surface layer of silver oxide and core of metal silver
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Abstract (Basic): CN 1241662 A
NOVELTY - Between or on the fabric fibers, superfine silver grains are adhered, which has surface layer of silver oxide and core of metal silver and size of 1-100 nm.
USE - The fabric may be used in people's daily life and may be also be used as functional fabric for treating skin infection of traumatic wound and fungi and preventing and treating infection of operational incision.
Dwg.0/0

1、一种纳米银长效广谱抗菌功能性织物，其特征在于在织物的纤维之间或纤维之上附着有超微粒银，超微粒银的表面层是氧化银，核心为金属银，其粒径为1～100纳米。

2、如权利要求1所述的纳米银长效广谱抗菌功能性织物，其特征在于在织物的纤维之间或纤维之上附着的超微粒银的量为2～200微克/厘米^2。

3、如权利要求1、2所述的纳米银长效广谱抗菌功能性织物的制备方法，其特征在于按配方配制整理剂，然后加入织物，湿润均匀，取出挤去多余溶液，用电熨斗或热辊机熨烫至织物呈黄褐色，再水洗多次，再熨烫平整。

4、如权利要求3所述的纳米银长效广谱抗菌功能性织物的制备方法，其特征在于以200公斤织物计整理剂含有：

$AgNO_3$	2～40 公斤，	NH_3H_2O	10～30 升，
氧化剂	20～50 升，	$C_6H_{12}O_6$	2 ～40公斤。

5、如权利要求4所述的纳米银长效广谱抗菌功能性织物的制备方法，其特征在于以200公斤织物计整理剂包括：

$AgNO_3$	2～40 公斤，	NH_3H_2O	10～30 升，
NaOH	0.8～4公斤，	氧化剂	20～50 升，
NH_4NO_3	10～30 公斤，	$C_6H_{12}O_6$	2 ～40公斤，
HNO_3	0.2～0.5 升，	C_2H_5OH	20～50 升，

余量为水 总计1000 升。

6、如权利要求3、4所述的纳米银长效广谱抗菌功能性织物的制备方法，其特征在于氧化剂可以是H_2O_2、$KCLO_4$、$NaCLO_4$、$HCLO_4$、（HNO_3+HCL）、（NaCL+HNO_3）、（NH_4CL+HNO_3）、（KCL+HNO_3）、发烟HNO_3、新鲜氯水、（H_2O_2+HNO_3）、（MnO_2+HNO_3）、（$KMnO_4$+HCL）、NaCLO，

纳米银长效广谱抗菌功能性织物及其制造方法

本发明是关于一种抗菌功能性织物及其制造方法，更特别的，是关于一种纳米银长效广谱抗菌功能性织物及其制造方法，是专利号为 92109288.1 的延续专利，国际专利分类号 D06M13/00 。

功能性纺织品为本世纪八十年代由德国科学家首先提出，并迅速在发达国家得到响应，世界各国均投入了大量资金进行研究开发，至今在可移植于人体的医用功能性织物上已有产品问世并应用于临床；但在非移植于人体的医用功能性织物未见突破，主要原因在于界定该织物的定义必须是以织物为载体的，稳定性好的，对人体疾病超高效、长效、低毒的治疗和辅助治疗功能等等，决不是那种简单用药品浸涂撒上的那种概念，实质上是一种全新的新型“药布”。

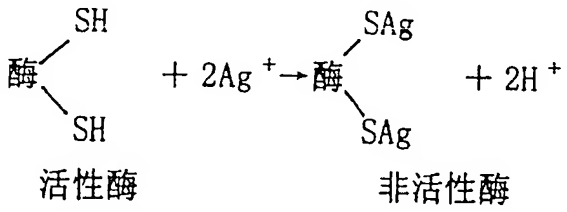
在日本专利昭 54 － 151669 中，公开了一种杀菌性布，其将含有铜、银（平均粒径 6 微米）的化合物单独或混合物的树脂溶液处理纱线，使该溶液均匀涂附在纱线的表面后再织成杀菌性布，该产品可作胶靴的衬里，帆布鞋和袜子。

在日本“加工技术” vol.17 NO7 报导中，用铜和硫化物处理腈纶纤维，得腈纶—硫化铜复合物，其对金葡球菌、大肠杆菌、枯草杆菌、皮肤丝状白癣菌有抑菌能力。

在中国发明专利 CN87100231A ，题目为“抗菌防臭纤维织物及制造方法”，公开日： 1987 年 11 月 18 日中公开了一种抗菌织物，其将腈纶织物先后与 Cu^{+}、碱性绿 4 复合交联，产品对金葡球菌、 MRSA 、白葡球菌、白色念珠菌等 10 个菌种有抑菌功能，其可用作抗菌防臭的内衣裤、袜、鞋垫和医药工业、食品工业的工作服。

在日本专利平 3 － 136649 、申请日： 1989 年 10 月 24 日中公开了一种预防奶牛乳房炎的抗菌布。其将银离子与聚丙烯腈以配位键形式复合，产品对链球菌、葡萄菌等 6 种菌种有抑制作用，可用作擦拭奶牛乳房乳头以预防奶牛的乳房炎的抗菌布。

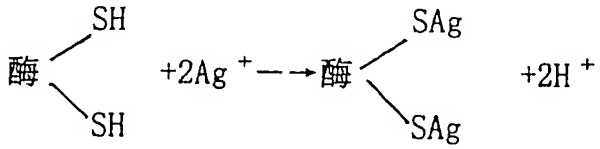
以上这些产品均有抗菌作用，但是抗菌谱不广、作用不明显，并且与本



Ag $^{+}$易与带阴电的细菌蛋白中的巯基－SH结合，使一些细菌赖以生存的活性酶丧失活性，从而达到抑菌效果。

本发明的纳米银长效广谱抗菌功能性织物，可以作为治疗烧伤的医用（外）功能性织物和作为治疗外伤患者的皮肤感染的功能性织物，并且还可作为治疗皮肤浅部真菌感染的功能性织物和作为外科手术切口术后预防和治疗切口感染的功能性织物。

在本发明中，根据经典理论，银具有较好的杀菌作用，杀菌机理为：



银是比较稳定的物质，基本不溶于水，且本身的杀菌力及抗菌谱既没有那么强也没有那么广，这在宏观世界中是不好解决的，故必须向纳米科学的微观世界中寻求答案，应用到临床对疾病的治疗和预防上。纳米银技术是建立在量子化学、材料化学、生物化学三大基础学科上的产物，通过将银的材料尺度上的细微化，使其达到 10^{-9}m 的纳米量级，充分利用它的表面效应、小尺寸效应和利用它反映出的不同于宏观世界银的各种新的特异性质和效应，实现其长效性、广谱性、抗菌强、稳定性好、遇水功效不但不减弱，反而增强的特性和在杀灭致病菌的过程中，不受人体酸碱度的影响等等特性。同时银的渗透力加强，促进生肌收敛，发挥其治疗功能。由于其表面积大大增加，表面结构也发生较大变化，表面活性大大增强，并表现出极高的特异性功能，经检测，对致病菌的MIC为0.16～8.97毫克/毫升，MBC为3.05～81.97毫克/毫升，其杀菌能力提高了200多倍。

应用纳米银技术制作出的纳米银织物在非移植于人体的医用功能性织物上具有广泛的应用前景，除可制作成各种抗菌敷料应用于人体体表、粘膜疾病外，同时还可预防疾病；另外，在人类生活、工作的各种抗菌性产品开发应用上更具广泛性，如制作成各种抗菌服、卧具、袜鞋等等纺织品、轻工产品和医院设备等。可以说，纳米银的应用，将使人类生活有一个质的提高，纳米银医用功能性织物必将掀起一轮新的产业革命，必将促进医用功能性织

粘质沙雷菌	分泌物	16	13	14	7	6	R	R	R	R	R	S
费劳地枸橼酸杆菌	分泌物	11	10	11	7	6	R	R	R	R	R	R
雷积普罗维登菌	分泌物	15	13	13	7	6	R	R	R	S	R	S
亲水气单胞菌	分泌物	13	11	13	7	16	R	R	R	S	R	S
温和气单胞菌	分泌物	14	12	12	7	17	R	I	I	S	R	S
创伤弧菌	分泌物	17	15	15	7	6	R	R	R	S	I	S
奇异变形杆菌	分泌物	11	10	10	7	9	R	R	R	S	R	R
普通变形杆菌	分泌物	11	9	11	7	6	R	R	R	S	R	R
潘氏变形杆菌	分泌物	10	9	10	7	6	R	R	I	S	R	S
白色念珠菌	分泌物	21	20	20	7	6						
热带念珠菌	分泌物	18	17	18	7	6						
近平滑念珠菌	分泌物	20	19	20	7	6						
光滑球拟酵母菌	分泌物	27	26	26	7	6						

注：S：敏感　　I：中介　　R：耐药

菌株	空白	AB 织物			LBDF 织物			
	织物	未洗	洗 20 次	高压	未洗	高压	洗 20 次	洗 50 次
绿脓杆菌	-	-	-	-	15	13	16	16
金黄色葡萄球菌	-	-	-	-	15	17	15	15
大肠杆菌	-	-	-	-	13	14	18	15
MRSA	-	-	-	-	14	14	17	15
蜡样杆菌	-	-	-	11	13	13	15	15
创伤弧菌	-	-	-	-	16	16	16	17
白色念珠菌	-	21	-	-	11	11	11	11
B 群溶血性链球菌	-	-	-	-	11	11	12	11
嗜麦芽假单胞菌	-	-	-	-	12	12	15	14
硝酸盐阴性杆菌	-	-	-	-	14	14	13	15
丙型副伤寒沙门氏菌	-	12	-	-	12	14	19	14
亚利桑那菌	-	-	-	-	14	14	15	14
枸橼酸杆菌	-	-	-	-	14	14	15	13
肺炎杆菌	-	-	-	-	13	13	17	13
枯草杆菌	-	-	-	-	12	12	12	12
摩根氏菌	-	-	-	10	12	12	12	12
粪产碱杆菌	-	-	-	-	14	12	16	16
斯氏普图菲登氏菌	-	-	-	-	12	12	14	13
阴沟肠杆菌	-	-	-	-	13	13	13	13
淋球菌	-	-	-	-	11	11	11	11

以上结果表明，LBDF 对 20 株细菌均有抑制作用，且对易产生抗药性的细菌，如金黄色葡萄球菌耐药株（MRSA），绿脓杆菌，嗜麦芽假单胞菌及硝酸盐阴性杆菌等均有抑制作用，高压及洗涤 20 次及 50 次后均与未经洗涤一样，对抑菌作用无明显影响，而 AB 织物经洗涤 20 次后，对以上细菌不能抑制，由此可见，LBDF 织物的抑菌范围双 AB 织物广泛且不会因为洗涤而影

称取 $AgNO_3$ 1 公斤，溶于 400 升水中，加入浓 $NH_3 \cdot H_2O$ 5 升、浓 NaOH 0.5 公斤、NH_4NO_3 5 公斤使之溶解并混合均匀。取葡萄糖 0.2 公斤、溶于 50 升水中，再加浓 HNO_3 0.1 升，乙醇 15 升。将这两种溶液混匀，在加入 100 公斤纯棉织物之前，现场配制双氧水溶液 10 升，将 100 公斤棉织物分别浸入处理溶液，浸泡 5 分钟，在室温（ 30 ℃）下搅拌使之充分湿润均匀，取出后挤去多余的溶液，然后用电熨斗或热辊机熨烫至织物呈现黄褐色，经多次水洗涤，再熨烫平整，即得本发明的产品。

例 3

称取 $AgNO_3$ 20 公斤，溶于 400 升水中，加入浓 $NH_3 \cdot H_2O$ 30 升、浓 NaOH 3 公斤、NH_4NO_3 30 公斤使之溶解并混合均匀。取葡萄糖 15 公斤、溶于 50 升水中，再加浓 HNO_3 0.2 升，乙醇 40 升。将这两种溶液混匀，在加入 100 公斤纯棉织物之前，现场配制新鲜氯水溶液 50 升，将 100 公斤棉织物分别浸入处理溶液，浸泡 4 分钟，在室温（ 30 ℃）下搅拌使之充分湿润均匀，取出后挤去多余的溶液，然后用电熨斗或热辊机熨烫至织物呈现黄褐色，经多次水洗涤，再熨烫平整，即得本发明的产品。

例 4

称取 $AgNO_3$ 15 公斤，溶于 400 升水中，加入浓 $NH_3 \cdot H_2O$ 24 升、浓 NaOH 2 公斤、NH_4NO_3 26 公斤使之溶解并混合均匀。取葡萄糖 12 公斤、溶于 50 升水中，再加浓 HNO_3 0.2 升，乙醇 30 升。将这两种溶液混匀，在加入 100 公斤纯棉织物之前，现场配制（ $NH_4CL + HNO_3$ ）与（ $KCL + HNO_3$ ）混合溶液 40L，NH_4CL 与 HNO_3、KCL 与 HNO_3 的比例为摩尔比，（ $NH_4CL + HNO_3$ ）与（ $KCL + HNO_3$ ）的比例为 1 ： 1.5，将 100 公斤棉织物分别浸入处理溶液，浸泡 4 分钟，在室温（ 30 ℃）下搅拌使之充分湿润均匀，取出后挤去多余的溶液，然后用电熨斗或热辊机熨烫至织物呈现黄褐色，经多次水洗涤，再熨烫平整，即得本发明的产品。

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Patent Claims 2 pages; Descriptions 7 pages

[54] Name of Invention: Fabric with Nanometer Silver Long-acting Wide-spectrum Antiseptic Function and the Method for Its Preparation

[57] Abstract

This invention discloses a fabric with nanometer silver long-acting wide (broad) spectrum antiseptic (disinfecting) function; superfine silver grains are adhered between or on the fabric fibers; the surface layer of the superfine silver particles are silver oxide, the cores (nuclei) of the silver particles are metallic silver; the particle size is 1~100 nanometer. The fabric may be used in peoples' daily life, or as a functional fabric for treatment of skin infection of traumatic wound and superficial fungal infection, or for post surgical incision preventive treatment and treatment of incision infection.

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Patent Claims

1. A fabric with nanometer silver long-acting wide spectrum antiseptic function, the characteristics of which are that superfine silver grains are adhered between or on the fabric fibers; the surface layer of the superfine silver particles are silver oxide, the cores (nuclei) of the silver particles are metallic silver; and the particle size is 1 ~ 100 nanometer.

2. A fabric with nanometer silver long-acting wide spectrum antiseptic function as in Claim 1, the characteristics of which are that the amount of superfine silver particles adhered between or on the fabric fibers is 2 ~ 200 μg (microgram)/cm^2.

3. The method for preparing fabric with nanometer silver long-acting wide spectrum antiseptic function as in Claims 1 and 2, the characteristics of which are that a finishing (treatment) solution is prepared according to a certain formulation, a fabric is then treated in the solution, after wetted uniformly, the fabric is removed from the solution, excess solution is squeezed out, an electric iron of heated roller is applied over the fabric until it is becoming yellowish brown (tawny), rinse repeatedly in water, ironed flat and leveled.

4. A method for preparing fabric with nanometer silver long-acting wide spectrum antiseptic function as in Claim 3, the characteristics of which are that the formulation of a finishing solution for 200 kg of fabric is consisting of the followings:

$AgNO_3$	2 ~ 40 kg,	Ammonia water	10 ~ 30 liters,
Oxidizing agent	20 ~ 50 liters,	$C_6H_{12}O_6$	2 ~ 40 kg.

5. A method for preparing fabric with nanometer silver long-acting wide spectrum antiseptic function as in Claim 3, the characteristics of which are that the formulation for a finishing solution for 200 kg of fabric is including of the followings:

$AgNO_3$	2 ~ 40 kg,	Ammonia water	10 ~ 30 liters,
NaOH	0.8 ~ 4 kg	Oxidizing agent	20 ~ 50 liters,
NH_4NO_3	10 ~ 30 kg	$C_6H_{12}O_6$	2 ~ 40 kg,
HNO_3	0.2 ~ 0.5 liters	C_2H_5OH	20 ~ 50 liters,

with remaining water to make up a total of 1,000 liters.

6. A method for preparing fabric with nanometer silver long-acting wide spectrum antiseptic function as in Claims 3 and 4, the characteristics of which are that the oxidizing agent may be: H_2O_2, $KClO_4$, $NaClO_4$, $HClO_4$, (HNO_3 + HCl), (NaCl + HNO_3), (NH_4Cl + HNO_3), (KCl + HNO_3), fuming HNO_3, fresh chlorine water, (H_2O_2 + HNO_3), (MnO_2 + HNO_3), ($KMnO_4$ + HCl), and NaclO (? $NaClO_4$). These oxidizing agents may be used singularly or as a mixture.

7. A fabric with nanometer silver long-acting wide spectrum antiseptic function as in Claims 1 and 2 , the characteristics of which are that it is used as a medical functional fabric applied externally for treatment of burns.

8. A fabric with nanometer silver long-acting wide spectrum antiseptic function as in Claims 1 and 2 , the characteristics of which are that it is used as a functional fabric applied externally for treatment of skin infection and superficial fungal infection.

9. A fabric with nanometer silver long-acting wide spectrum antiseptic function as in Claims 1 and 2 , the characteristics of which are that it is used as a functional fabric for preventive treatment of surgical incision or treatment of incision infection.

10. A fabric with nanometer silver long-acting wide spectrum antiseptic function as in Claims 1 and 2 , the characteristics of which are that it is used as in articles of daily life.

Fabric with Nanometer Silver Long-acting Wide-spectrum Antiseptic Function and the Method for Its Preparation

This invention concerns a fabric with antiseptic function and the method for its preparation, more particularly, it concerns a fabric with nanometer silver long-acting wide spectrum antiseptic function, it is an extension patent of patent No. 92109288.1, international patent classification No. D06M 13/00.

Functional fabric was first proposed by German scientists in the 80's; it was quickly received responses in the developed nations, various countries (in the world) invested a substantial amount of capitals for its research and development; today, there are functional medical products available for clinical applications in human transplantation; however, there is no break through in functional medical product for non-human transplantation application; the primary reasons are that the definition of material must use a fabric as a carrier, has good stability, is highly effective, long-acting, and low toxicity in the treatment or assisting in the treatment of human diseases; it is definitely not a concept of simple application of medication, but rather involves a new type of "medicated cloth".

In a Japanese patent No. Sho 54-151669, it disclosed a disinfecting cloth which involves the treatment of yarn with resin solution containing copper and silver (average particle size 6 micrometers) compound singularly or mixture, allowing the solution to coat uniformly over the surface of the yarn and weaved into a cloth; the cloth may be used as a lining for sneakers, canvas shoes, or socks.

Reported in Japanese "Processing Technology" Vol. 17, No.7 was the treatment of acrylic fiber with copper and sulfur compounds to obtain a acrylic-copper sulfide composite, which shows antiseptic activity against staphylococcus aureus, E. coli, baccillus subtilis, and dermal filamentous tinea alba (white ringworm) bacteria.

In a Chinese invention patent No. CN 87100231A, entitled "Antiseptic Deodorizing Woven Fabric and Its Method of Preparation", published November 18, 1987, it disclosed a antiseptic fabric, in which acrylic fabric was cross-link combined successively with Cu^{+}, and malachite green 4; the product has antiseptic activity against staphylococcus aureus, MRSA (methicillin resistant staphylococcus aureus), staphylococcus albus, and candida allbicans, etc., ten different bacteria; it can be used in antiseptic deodorizing underwear, socks, shoe cushions, and for clothing in the medical & pharmaceutical, and food industries.

In Japanese patent Hei 3-136649, applied in October 10, 1989, it disclosed an antiseptic cloth for prevention of mastitis for cow. In which silver ions and acrylic fibers are combined through coordination bonds; the product has antiseptic activity against streptococcus and staphylococcus, etc., 6 types of bacteria; the cloth may be used an antiseptic cloth for wiping the nipples of cow to prevent mastitis.

The products mentioned above all have antiseptic activity; however, the antiseptic spectrum is not very wide, and the activity not very distinct, they are totally different from this invention.

The first objective of this invention is to provide a cloth with antiseptic function and its method of preparation.

The second objective of this invention is to provide a fabric with nanometer silver long-acting wide spectrum antiseptic function.

And the third objective this invention is to provide the method for the preparation of a fabric with nanometer silver long-acting wide spectrum antiseptic function.

These objectives and other objectives are explained through the following detailed explanations and further descriptions.

In a fabric with nanometer silver long-acting wide spectrum antiseptic function of this invention, superfine silver particles are adhered between or on the fabric fibers; the surface layer of the superfine silver particles are silver oxide, the cores (nuclei) of the silver particles are metallic silver; the particle size is 1 ~ 100 nanometer; the amount of superfine silver particles adhered between or on the fabric fibers is 2 ~ 200 μg (microgram)/cm^2.

The method of preparation of the fabric with nanometer silver long-acting wide spectrum antiseptic function of this invention includes preparation of a finishing solution according to a certain formulation; a fabric is then treated in the solution, after wetted uniformly, the fabric is removed from the solution, excess solution is squeezed out, an electric iron of heated roller is then applied over the fabric until it is becoming yellowish brown (tawny), the fabric is rinsed repeatedly in water, ironed flat and leveled; the finishing solution (based on 200 kg of fabric) is consisting of the followings:

$AgNO_3$	2 ~ 40 kg,	Ammonia water	10 ~ 30 liters,
Oxidizing agent	20 ~ 50 liters,	$C_6H_{12}O_6$	2 ~ 40 kg

Furthermore, the finishing solution (based on 200 kg of fabric) of this invention is also including the followings:

$AgNO_3$	2 ~ 40 kg,	Ammonia water	10 ~ 30 liters,
NaOH	0.8 ~ 4 kg	Oxidizing agent	20 ~ 50 liters,
NH_4NO_3	10 ~ 30 kg	$C_6H_{12}O_6$	2 ~ 40 kg,
HNO_3	0.2 ~ 0.5 liters	C_2H_5OH	20 ~ 50 liters,

and with remaining water to make up a total of 1,000 liters.

In which, the oxidizing agent may be: H_2O_2, $KClO_4$, $NaClO_4$, $HClO_4$, (HNO_3 + HCl), (NaCl + HNO_3), (NH_4Cl + HNO_3), (KCl + HNO_3), fuming HNO_3, fresh chlorine water, (H_2O_2 + HNO_3), (MnO_2 + HNO_3), ($KMnO_4$ + HCl), and NaClO (? $NaClO_4$). These oxidizing agents may be used singularly or as a mixture.

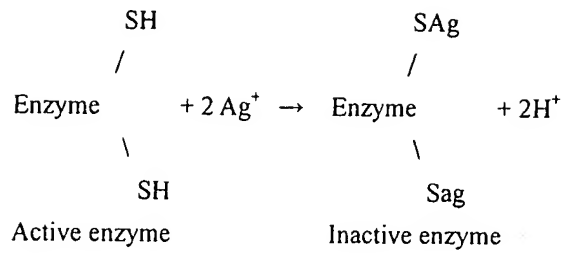
The reaction mechanism is:

$$Ag^+ + 2\ NH_3 \rightarrow [Ag\ (NH_3)_2]^+$$

$$[Ag\ (NH_3)_2]^+ + C_6H_{12}O_6 \rightarrow Ag$$

$$Ag + \text{Oxidizing Agent} \rightarrow Ag_2O$$

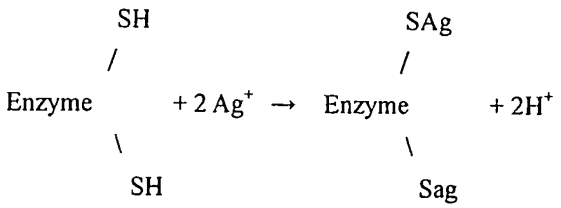
The antiseptic mechanism is: $Ag_2O + H_2O \rightarrow 2\,Ag^+ + 2\,OH^-$



Ag^+ can easily bind to the mercapto (– SH) groups of protein of the bacteria, making the active enzyme necessary for the bacteria to survive loss its activity, thus achieve the antiseptic effect.

The fabric with nanometer silver long-acting wide spectrum antiseptic function of this invention may be used as a medical functional fabric applied externally for treatment of burns, and as a functional fabric applied externally for treatment of skin infection and superficial fungal infection, as well as a functional fabric for preventive treatment of surgical incision or treatment of incision infection.

In this invention, according to classical theory, silver has a better sterilization effect; the mechanism of which is:



Silver is a substance that is more stable, it is sparingly soluble in water; the bactericidal power and antiseptic spectrum of which is neither very strong nor very wide; this problem can not be easily resolved in a macroscopic world. Therefore, we are reaching out to the microscopic world to look for answers of treatment for clinical diseases and their prevention. Nanometer silver technology is a product establish based on three major basic sciences (branches of chemistry) – quantum chemistry, material chemistry, and biochemistry; through miniaturization on the dimension of the silver material, reaching 10^{-9} meter or nanometer range, it is fully making use of its surface effect and micro dimensional effect, various new distinctive properties and effects that are different from the macro world silver; it is displaying a long-acting, wide-spectrum, highly antiseptic, good stability, and the special property of not decrease but rather increase of these characteristics in the presence of water, and the property that its bactericidal power against disease causing bacteria (pathogens) is not affected by the acidity or alkalinity in the human body. At the same time, as the penetrating power of silver is increasing, it promotes myogenic astringency, demonstrating its therapeutic functions. Because its surface area is greatly increased, and a pronounced change in the surface structure, the surface activity is greatly enhanced, and has demonstrated certain extremely distinctive properties. Test results have shown that the MIC for pathogen is 0.16 ~ 8.79 mg/ml, MBC is 3.05 ~ 81.97 mg/ml; its bactericidal power has increased by more than 200 times.

The application prospect of using nanometer silver fabric prepared from nanometer silver technology as non-transplanted human medical functional fabric is wide ranging; besides preparation of various antiseptic dressings for treatment of superficial skin and mucous membrane diseases, it may also be used for prevention of diseases; in addition, it has a wide application potential in the development of various antiseptic products in our daily life and work, for example, preparation of fabrics for various antiseptic clothing, bedding materials, socks and shoes, etc., as well as light industrial products and implementations and furnishings in hospitals, etc.. One may say that the application of nanometer silver, will improve the quality of our life, the medical functional fabric application of nanometer silver will set off a new round of industrial revolution; it will undoubtedly further promote rapid growth and development of medical functional fabric industry.

Test results of the nanometer silver long-acting broad-spectrum disinfecting fabric (refer to as LBDF below) of this invention have shown that the various indexes are as follows:

1. Long-acting Property:

External (in vitro) antiseptic tests are carried out for test samples through the following three forms of processing, together with original LBDF that has not been through any processing; test results have shown that the antiseptic activity is basically unchanged for the processed LBDF and the original unprocessed LBDF samples.

A. Washed 50 times, each time is manually washed with soap, followed by rinsing with clear (plain) water, total 50 times;

B. Washed 100 times, each time is (manually) washed with clear water, total 100 times;

C. Immerse LBDF in water for 45 days (water is changed daily).

2. Broad Spectrum Property:

A. Carried out in vitro antiseptic MH plate (or Columbia agar plate, or blood plate) tests, (bacteria) strain identification and drug sensitivity (potency) tests using Vitek – 32 fully automatic microbiological analyzer by French Meliei (?) Company. In vitro antiseptic test bacteria strains include Gram-positive bacterium, Gram-negative bacterium, fungus (eumycetes), and spores, etc., a total of more than forty pathogens. Test results have shown that LBDF have distinctive antiseptic activity against all forty plus pathogens; except a few are international standard strain the majority of the remaining forty plus pathogens are strains isolated from patients' secretions, the bacteriostatic effect of which are more difficult to achieve.

The above in vitro antiseptic tests were conducted by the microbiological laboratory of the All Army Drug Test Center of the Army of Peoples' Republic of China, and bacteria laboratory of Hua Shan Hospital of Shanghai Medical University, both which are well noted laboratories in the country.

Bacteriostatic Test Results of LBDF Antiseptic Fabric and 8 Antibiotic Drugs

	Comparison of Bacteriostatic Diameter (in mm) of LBDF Antiseptic Fabric vs. Control					MIC of (Antibiotics) Drug Sensitivity Test Results						
Name/Source of Bacteria	Not washed	Washed 50 X	Washed 100 X	Negative Comps'n	Erotho-mycin	A	B	C	D	E	F	G
1	18	15	15	7	24	S	S	S	S	S	S	S
2	13	13	12	7	10		S	S	S	S	S	S
3	12	12	12	7	6					S	S	S
4	10											
5	17	15	15	7	6	R	R	R	R	R	R	R
6	18	15	16	7	6	R	R	R	R	R	R	R
7	9	8	8	7	6	S	S	S	S	S	S	S
8	10	10	10	7	31		S	S	S	S	S	S
9	17	14	14	7	6		R	R	R	R	R	R
10	9	8	8	7	11		R	R	R	R	R	R
11	14	12	13	7	6		R	R	R	R	R	R
12	15	15	15	7	6		R	R	R	R	R	R
13	14	13	14	7	6		R	R	R	S	R	S
14	13	12	12	7	19		R	R	R	S	S	S
15	15	14	14	7	6		R	R	R	S	R	S
16	16	13	14	7	6		R	R	R	R	R	S
17	11	10	11	7	6		R	R	R	R	R	R
18	15	13	13	7	6		R	R	R	S	R	S
19	13	11	13	7	16		R	R	R	S	R	S
20	14	12	12	7	17		R	I	I	S	R	S
21	17	15	15	7	6		R	R	R	S	I	S
22	11	10	10	7	9		R	R	R	S	R	R
23	11	9	11	7	6		R	R	R	S	R	R
24	10	9	10	7	6		R	R	I	S	R	S
25	21	20	20	7	6							
26	18	17	18	7	6							
27	20	19	20	7	6							
28	27	26	26	7	6							

Notes: S: Sensitive I: Intermediary R: (Drug) resistant

A: Oxacillin B: Ampicillin C: Cefazolin D: Cefuroxime E: Ceftazidime

F: Gentamycin G: Ciprofloxacin

1: Staphylococcus aureus ATCC25923
2: E. coli ATCC25922
3: Pseudomona verdigris ATCC27853
4. Bacillus aerogenes capsulatus CMCC (B)64606
5. Methicillin resistant staphylococcus aureus (MRSA) secretion
6. Methicillin resistant staphylococcus epidermidis (MRSE) secretion
7. Streptococcus pyogenes secretion
8. Neisseria gonorrhoeae secretion
9. E. coli secretion
10. Enterobacter closacae secretion
11. Clostridium perfringin secretion
12. Pseudomona verdigris secretion
13. Pseudomona maltophilia secretion
14. Bowman acinetobacter secretion
15. Klebseilla pneumoniae secretion
16. Bacillus prodigiosus secretion
17. Cetrobacter freundii secretion
18. Providencia rettgeri secretion
19. Aeromonas hydrophilia secretion
20. Aeromonas sorbria secretion
21. Virio vulnus secretion
22. Bacillus proteus mirabilis secretion
23. Bacillus proteus vulgaris secretion
24. Bacillus proteurs penneri secretion
25. Candida albicans secretion
26. Candida tropicalis secretion
27. Candida parapsilosis secretion
28. Torulopsis glabrata secretion

Strain of	Blank	AB Fabric			LBDF Fabric			
Bacteria	Fabric	Unwash'd	Wash'd 20x	Atclv'd	Unwash'd	Atclv'd	Wash'd 20x	Wash'd 50x
1	-	-	-	-	15	13	16	16
2	-	-	-	-	15	17	15	15
3	-	-	-	-	13	14	18	15
4	-	-	-	-	14	14	17	15
5	-	-	-	11	13	13	15	15
6	-	-	-	-	16	16	16	17
7	-	21	-	-	11	11	11	11
8	-	-	-	-	11	11	12	11
9	-	-	-	-	12	12	15	14
10	-	-	-	-	14	14	13	15
11	-	12	-	-	12	14	19	14
12	-	-	-	-	14	14	15	14
13	-	-	-	-	14	14	15	13
14	-	-	-	-	13	13	17	13
15	-	-	-	-	12	12	12	12
16	-	-	-	10	12	12	12	12
17	-	-	-	-	14	12	16	16
18	-	-	-	-	12	12	14	13
19	-	-	-	-	13	13	13	13
20	-	-	-	-	11	11	11	11

Notes: The number for bacteria strain is as followings:

1. Bacillus pyocyaneus
2. Staphylococcus aureus
3. E. coli
4. Methicillin resistant staphylococcus aureus
5. Bacillus cereus
6. Virio vulnus
7. Candida albicans
8. β Hemolytic streptococcus
9. Pseudomona maltophilia
10. Nitrate-negative bacillus
11. Salmonella paratyphi C
12. Salmonella arizonae
13. Citrobacter
14. Pneumobacillus
15. Bacillus subtilis
16. Proteus morgani
17. Bacillus focalis alkaligenes
18. Providencia stuartii
19. Enterpbacter cloacae
20. Gonococcus

The above results demonstrate that LBDF has antiseptic effects on 20 strains of bacteria, and is showing an effective antiseptic activity against easily induced drug resistant strains, such as methicillin resistant staphylococcus aureus bacteria strain (MRSA), bacillus pyocyaneus, pseudomona maltophilia, and nitrate-negative bacillus; autoclaving, washing 20 times, or washing 50 times, comparing against unwashed fabric, have shown no visible effect on the antiseptic activity of the fabric; on the other hand, AB fabric is ineffective against the strains mentioned above after only 20 times of washing; it can be seen from the above that LBDF fabric has a broader bacteriostatic spectrum than AB fabric, which is not affected by washing.

3. LBDF has excellent Bacteriostatic Function and Activity against Drug Resistant Pathogens

In vitro antiseptic tests were conducted for LBDF fabric and 8 antimicrobials against 28 pathogens, the results indicate that LBDF has visible bacteriostatic function against all 28 pathogens, while erythromycin is effective against only 8 pathogens, oxacillin (2 strains), ampicillin (4 strains), cefazolin (4 strains), cefuroxime (4 strains), ceftazidime (15 strains), gentamycin (6 strains), and ciprofloxacin (14 strains).

In vitro test results have demonstrated that comparing to these 8 antimicrobial drugs, LBDF has visible advantages in the bacteriostatic function on drug resistant strains.

4. Study on Pharmacokinetics

Using guinea pig and (household) rabbit as test objects, LBDF is used in skin acute toxicity test, irritation test, and allergy test. The tests were conducted by the Pharmacology Department of the General Hospital of the Nanjing Military Command. Test results have shown that LBDF is non-toxic, non-irritable, and non-allergenic.

5. Clinical Tests

Clinical tests have been carried out after the above tests, currently, it include:

1). Clinical study (report) of Burn Plastic Surgery Department of the Nanjing General Hospital of the Army of the People's Republic of China.

2). Clinical study (report) of Type II incision post surgical observation by the General Surgical Department of the Jiangsu Provincial Peoples' Hospital.

3). Clinical study (report) on superficial dermal pathogens by the Dermopathic Research Laboratory of the China Medical Science University.

In addition, several hospitals currently are also conducting clinical observations on skin grafting area, cancer post surgery incision, burn and scald wound, and skin ulcer, etc..

This invention is further explained through the following specific examples; these examples are used for explanation only, they are not limiting the scope of this invention.

In this invention, unless otherwise specified, all parts, quantities are expressed in the weight units based on the total weight.

Example 1

Weigh out 10 kg of $AgNO_3$ and dissolve in 400 liters of water; add 15 liters of concentrated ammonia water, and 3 kg of concentrated NAOH, and 20 kg of NH_4NO_3, allow to dissolve and mix uniformly. Weigh out 10 kg of glucose, dissolve in 50 liters of water, and add 0.1 liter of concentrated HNO_3 and 30 liters of ethanol. The two solutions are mixed uniformly together, freshly prepare 25 liters of NaCl + HNO_3 (in molar ratio) solution, before applying to 100 kg of pure cotton fabric; immerse 100 kg of cotton fabric in the treatment solutions, respectively, for 5 minutes, stir at room temperature (20^oC) to allow complete wetting of the fabric; squeeze out excess solution after removal from the solution; use an iron or hot roller to go over the fabric until it is yellowish brown, rinse repeatedly with water, iron flat and level out to obtain the product of this invention.

Example 2

Weigh out 1 kg of $AgNO_3$ and dissolve in 400 liters of water; add 5 liters of concentrated ammonia water, and 0.5 kg of concentrated NAOH, and 5 kg of NH_4NO_3, allow to dissolve and mix uniformly. Weigh out 0.2 kg of glucose, dissolve in 50 liters of water, and add 0.1 liter of concentrated HNO_3 and 15 liters of ethanol. The two solutions are mixed uniformly together, freshly prepare 10 liters of hydrogen peroxide solution before applying to 100 kg of pure cotton fabric; immerse 100 kg of cotton fabric in the treatment solutions, respectively, for 5 minutes, stir at room temperature (30^oC) to allow complete wetting of the fabric; squeeze out excess solution after removal from the solution; use an iron or hot roller to go over the fabric until it is yellowish brown, rinse repeatedly with water, iron flat and level out to obtain the product of this invention.

Example 3

Weigh out 20 kg of $AgNO_3$ and dissolve in 400 liters of water; add 30 liters of concentrated ammonia water, and 3 kg of concentrated NAOH, and 30 kg of NH_4NO_3, allow to dissolve and mix uniformly. Weigh out 15 kg of glucose, dissolve in 50 liters of water, and add 0.2 liter of concentrated HNO_3 and 40 liters of ethanol. The two solutions are mixed uniformly together, freshly prepare 50 liters of chlorine water solution before applying to 100 kg of pure cotton fabric; immerse 100 kg of cotton fabric in the

treatment solutions, respectively, for 4 minutes, stir at room temperature ($30^{o}C$) to allow complete wetting of the fabric; squeeze out excess solution after removal from the solution; use an iron or hot roller to go over the fabric until it is yellowish brown, rinse repeatedly with water, iron flat and level out to obtain the product of this invention.

Example 4

Weigh out 15 kg of $AgNO_3$ and dissolve in 400 liters of water; add 24 liters of concentrated ammonia water, and 2 kg of concentrated NAOH, and 26 kg of NH_4NO_3, allow to dissolve and mix uniformly. Weigh out 12 kg of glucose, dissolve in 50 liters of water, and add 0.2 liter of concentrated HNO_3 and 30 liters of ethanol. The two solutions are mixed uniformly together, freshly prepare 40 liters of a mixture of (NH_4Cl + HNO_3) and (KCl + HNO_3) solution, the ratio of NH_4Cl & HNO_3, & KCl and HNO_3 are in molar ratios, the ratio of (NH_4Cl + HNO_3) and (KCl + HNO_3) is 1 : 1.5, before applying to 100 kg of pure cotton fabric; immerse 100 kg of cotton fabric in the treatment solutions, respectively, for 4 minutes, stir at room temperature ($30^{o}C$) to allow complete wetting of the fabric; squeeze out excess solution after removal from the solution; use an iron or hot roller to go over the fabric until it is yellowish brown, rinse repeatedly with water, iron flat and level out to obtain the product of this invention.